

# Physical Constants of IC Package Materials





# CHAPTER 5

## PHYSICAL CONSTANTS OF IC PACKAGE MATERIALS

The Table 5-1 through Table 5-5 list typical values for selected properties of materials used in IC packages.

**Table 5-1. Case Material Characteristics**

Properties	Units	Alumina (92%)	Kovar	Molding Compound	Sealing Glass	Cu-W (90%)
Density	kg/m <sup>3</sup> (g/cc)	3600-3700 (3.6-3.7)	8400 (8.4)	1790-1850 (1.79-1.85)	4700 (4.7)	17000 (17)
Modulus of Elasticity	GPa	55	138	E <sub>1</sub> = 11.7 E <sub>2</sub> = 0.1	5.7	255
Tensile Strength	MPa	157	627	19.98		
Thermal Conductivity (20°C)	W/mK	18	17.5	0.58 - 0.67	0.6	180 - 200
Coefficient of Thermal Expansion	ppm/°C	6.8 (25°C - 400°C)	5.3 (40°C - 250°C)	a <sub>1</sub> ≤ 23 a <sub>2</sub> ≤ 80 (40°C - 250°C)	6.3 - 7.0 (40°C - 250°C)	6.5 (25°C - 500°C)
Electrical Resistivity	Ω cm	10 <sup>14</sup>	49 X 10 <sup>-6</sup>	5 X 10 <sup>12</sup>	>10 <sup>11</sup>	<6 X 10 <sup>-6</sup>
Dielectric Constant (1 MHz)		7.9 - 10.0	NA	≤ 5.0	11.5	NA
Flammability Rating*	in.			1/8		

**NOTE:** \*UL-94V-0

**Table 5-2. Lead/Lead Frame Material Characteristics**

Properties	Units	Copper Alloy MF 202	Alloy 42	Kovar	TAMAC4	CDA 194	OLIN 7025	EFTEC 64T
Density	kg/m <sup>3</sup> (g/cc)	8880 (8.8)	8100 (8.1)	8400 (8.4)	8900 (8.9)	8800 (8.8)	8800 (8.8)	8900 (8.9)
Modulus of Elasticity	GPa	113	145	138	123	121	131	119
Tensile Strength	MPa	490-590	588-735	627	450-510	480-519	527	560
Thermal Conductivity (20°C)	W/mK	160	15.7	17.5	190	263	166	300
Coefficient of Thermal Expansion	ppm/°C	17.0	4.5	5.3	16.7	16.3	17.1	17.0
Electrical Resistivity	Ω cm	5.7 X 10 <sup>-6</sup>	57 X 10 <sup>-6</sup>	49 X 10 <sup>-6</sup>	3.5 X 10 <sup>-6</sup>	2.6 X 10 <sup>-6</sup>	4.3 X 10 <sup>-6</sup>	2.3 X 10 <sup>-6</sup>

**Table 5-3. Solder Material Melting Temperatures**

Solder Type	Tmp (°C)
Sn-Pb Plating (85 wt% Sn)	200 - 225
Sn-Pb Eutectic (62 wt% Sn)	183
Tin	232
Lead	327
Gold	1063
Copper	1083
Silver	961
Copper/Silver Braze (28 wt% Cu)	850
Au-Sn Eutectic (80 wt% Au)	280

**Table 5-4. Die Attach Material Characteristics**

Property	Units	Silver Filled Glass	Silver Filled Adhesive	Silver Filled Epoxy	99.99% Au + 2% Si	99.99% Au
Density	kg/m <sup>3</sup> (g/cc)	4500 (4.5)		2500 (2.5)	14500 (14.5)	19300 (19.3)
Modulus Elasticity	GPa		0.77		69.5 (Data for Au + 3% Si)	62.5
Tensile Strength	MPa	> 10.			500-600	130
Thermal Conductivity	W/mK	270	2.5 @ 121°C	1.6 @ 121°C	50	311
Coefficient of Thermal Expansion	ppm/°C	8	a <sub>1</sub> = 40 a <sub>2</sub> = 150	a <sub>1</sub> = 46 a <sub>2</sub> = 240	50 @ 25°C	14.2 @ 25°C
Electrical Resistivity	Ω cm	1x10 <sup>-5</sup>	1 X 10 <sup>-4</sup>	2 X10 <sup>-4</sup>	3.1 X 10 <sup>-4</sup>	2.21 X 10 <sup>-6</sup>

**Table 5-5. TCP Package Materials Characteristics**

Property	Units	Polyimide	Adhesive	Cu-Foil Rolled	Cu-Foil Electro-Deposited	Encapsulant
Density	kg/m <sup>3</sup> (g/cc)	1470 (1.47)	1500 - (1.5)	8931 (8.9)	8931 (8.9)	1330 (1.33 uncured)
Modulus Elasticity	GPa	9 @ 25°C 4 @ 300°C	8 @ 25°C	127.4	127.4	6.55 @ 25°C
Tensile Strength	MPa	400	40 - 100	~ 450	532	
Thermal Conductivity	W/mK	0.2	0.1 - 0.2	390	390	0.52
Coefficient of Thermal Expansion	ppm/°C	12 - 18 25°C - 300°C	30 - 60 25°C - 300°C	16.7 25°C	16.7	a <sub>1</sub> = 18.6 a <sub>2</sub> = 84.9
Electrical Resistivity	Ω cm	>1 X 10 <sup>15</sup>	>10 <sup>16</sup> (0%RH)  >10 <sup>15</sup> (55%RH)	1.7 X 10 <sup>-6</sup>	1.7 X 10 <sup>-6</sup>	
Dielectric Constant		3.5 (KHz)	3.0 (1 KHz)	NA	NA	3.8 (1 KHz)